STUDY OF THE BASALT FACIES OF LÁZTETŐ HILL AT UZSA (BALATON HIGHLAND)

L. BOGNÁR

Geochemical Research Laboratory, Hungarian Academy of Sciences, Budapest
(Received: 15th VII. 1964)

SUMMARY

The paper is dealing with the study of the basaltic rocks of the Láztető at Uzsa, a member of the Tátika hill group made up of basalts, north-west of Lake Balaton.

On Láztető Hill 6 major types of basaltic rock can be distinguished:

1. Basalt tuff and tuffite
2. Basaltic agglomerate and breccia
3. Zeolitic olivine basalt
4. Scoriaceous and vesicular basalt lava
5. Exometabasalt (red oxibasalt)
6. Basaltic pseudo-agglomerate

The observations have shown that during the mineralization processes there occurred repeated formation of magnetite, plagioclase, augite and zeolites. Zeolitization confined to the vesicles was partly brought about by the alteration of exogenic inclusions which consisted mainly of clayey rocks. The degree of zeolitization was influenced, besides the chemical composition, only by the water content most of which originated in the wet underlying rocks. Petrofabric studies suggest that the rock may have consolidated in a lava pool.

As a contribution to the up-to-date geochemical and petrographic treatment of the Hungarian basalts in the spirit of E. Szádeczky-Kardoss' petrologic principles, an up-to-date examination of the basalts of the Tátika hill group has been undertaken. The present paper summarizes the results arrived at during investigations into the basalts of the Láztető at Uzsa.

Our task was to construct the petrographic map and profile of the Láztető (figs 1, 2) as well as to examine the distribution and genesis of the basalt types and of the zeolites. Our investigations have permitted to distinguish 6 different rock types. The relationship between the inclusions and the zeolites has been faced as a new problem which induced us to start an additional series of analyses still under way.

The identification of the zeolites on the basis of their possible trace elements was also aimed at, but these investigations have furnished negative results. Even though accounting for 5 per cent of the rock on the average, the zeolites of the Uzsa basalt contain hardly any trace elements.

The basalt volcanoes of Transdanubia overlie Permian sandstones, Triassic Hauptdolomit and Pannonian sediments. Lóczy (7) distinguished three groups according to their position above sea level. These groups differ in the age of the eruptions, too: *a)* most ancient, extensive lava sheets whose base lies 400 m a.s.l., *b)* mainly isolated volcanic cones sitting on the Pannonian surface 300 to 480 m a.s.l., *c)* the youngest representatives of the basaltic

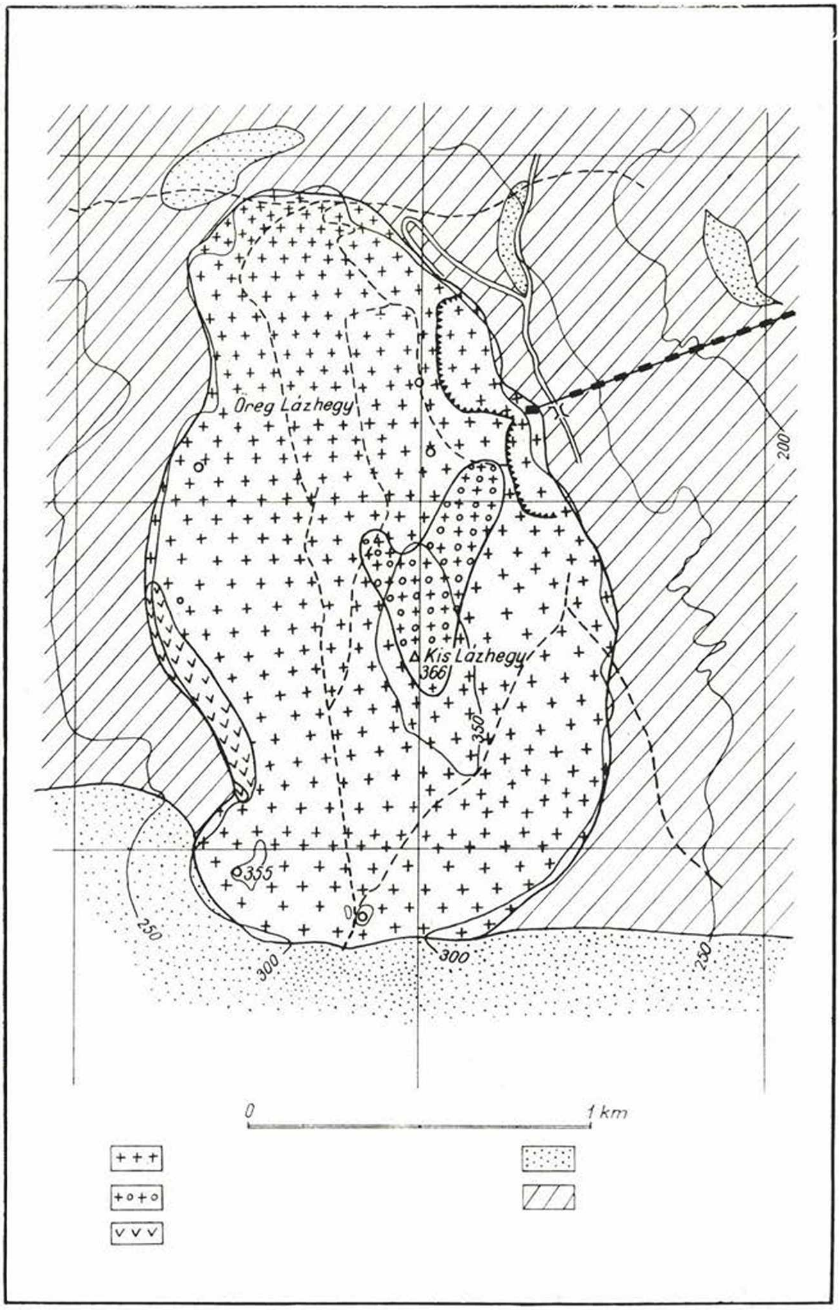

Fig. 1: Geological map of the Láztető
++ basalt
+o oxibasalt
vv basalt tuff
: : Pannonian sand
// loess

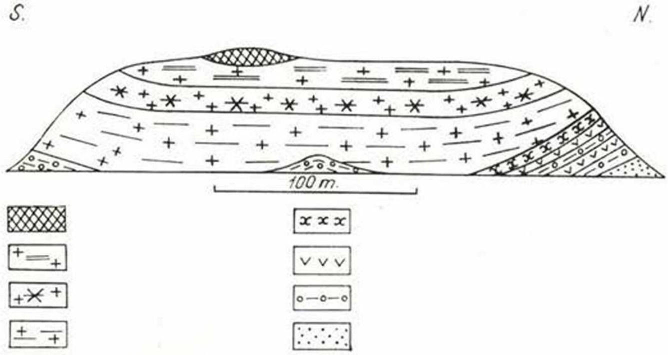

Fig. 2: Schematic geological profile of the quarry on Láztető
Legend, downwards:

oxibasalt	scoriaceous basalt
upper, thick-bedded basalt horizon	basalt tuff
middle, columnar basalt horizon	pseudo-agglomerate
lower, thick-bedded basalt horizon	Pannonian sand

volcanism are situated at 140 to 150 m a.s.l., in valleys incised deeply into the Pannonian deposits.

The basalt sheet of the Tátika hill group can be regarded as belonging to type *b)*. One of its members is the basalt plateau of the Láztető having an area of 2,5 sq. km. with an average height of 340 m a.s.l. Morphologically, it can be divided into three parts: the Öreg Lázhegy (Nagy Lázhegy) in the N, the Kis Lázhegy (Vörösföldtető) in the centre, and the Kávéhegy at the SW extremity of the basalt plateau.

The basalt sheet lies on Pannonian deposits consisting of sandstones and clays at heights of 290 to 300 m a.s.l. Its lower boundary can be traced only morphologically, since the Pannonian is covered in some places by loess, in other places by basalt detritus.

The fossils of the underlying sedimentary rocks have been described by I. Vitális (15), the basalts have been studied by B. Mauritz (8, 9) and L. Jugovics (2, 3, 4, 5). Our investigations permit to distinguish six rock types as follows:

1. Basalt tuff and tuffite
2. Basaltic agglomerate and breccia
3. Zeolitic olivine basalt
4. Scoriaceous and vesicular basalt lava
5. Exometabasalt (red oxibasalt)
6. Basaltic pseudo-agglomerate

Much of the Láztető is covered by partly zeolitized basalts exhibiting varied grey colours. On the Vörösföldtető there are oxibasalts, while on the SW side of the plateau some basalt tuffs also occur. In the quarry on the hill Láztető the presence of all the rock types can be demonstrated. Moreover, in the N part of the quarry as many as three superimposed horizons of zeolitic olivine basalts can be distinguished.

Description of the rock types

1. Basalt tuff and tuffite. They gradually develop from fine-grained tuffaceous sandstones at the northern extremity of the quarry. The sandstones alternate irregularly with basaltic agglomerates. Two-thirds of the tuffaceous sandstones consist of quartz grains (30 to 300 μ). The rock contains some pyroclastics and is cemented by carbonate. The lava grains stained by limonitization are within the size range of 500 to 1000 μ, their matrix is vitreous in which intact-edged plagioclase laths of $50-80\ \mu \times 5-10\ \mu$ size can only be recognized. Some calcite, muscovite and biotite can also be detected as accessory components. Besides limonitic stain, some green chloritic one can also be observed in several places.

In the conical formation in the centre of the quarry as well as at the higher tuff levels of the northern extremity it is the volcanic material that predominates. The lava grains average $1-2$ mm across, with sporadical lapilli of $1-2$ cm size. The cement is here phillipsite, locally calcite and serpentine. The abundance of clastic quartz is 4 to 5 percent, this mineral having here the same habit as in the tuff-bearing sandstones of the northern extremity of the quarry.

A third type of basalt tuff can be detected on the SW edge of the Láztető. The lava has a grain size similar to that mentioned above, but its glassy matrix includes, along with plagioclase, some mafic components, intact augite and iddingsitic olivine as well. In several "lava drops" the plagioclases have been arranged following the shape of the drop. The matrix consists predominantly of calcite, other sedimentary components being very scarce.

2. Basaltic agglomerate and breccia. Their main feature is the presence of lava lapilli of different sizes (from 0.1 mm to 50.0 mm $\varnothing$). They are cemented by clay minerals (Mg-montmorillonites as suggested by the DTA graphs), to a lesser extent by carbonates. Their chief allotigenic component is quartz, the heavy minerals being subordinate. The brecciated horizons are often made up of angular basalt detritus with hardly any cement.

3. Zeolitic olivine basalt. In the northern part of the quarry, at the deepest level one frequently encounters cavities a few mm across, some of which are filled by zeolite, while the upper part of the basalt horizon shows platy partings, getting thicker (20 to 50 cm) in the higher portions of the profile.

In the lower horizon which makes up the bulk of the quarry face the largest exposed thickness of the basalt is 20 m. Farther on towards the centre of the quarry it is thicker by some 10 m – as suggested by drillings – and then, rising together with the underlying horizons, it wedges out in a direction of 194/30° at the northern extremity of the quarry. The zeolitic vesicles, the clay and sandstone inclusions as well as the larger olivine grains are readily visible in it even to the naked eye. The larger inclusions occur more frequently in the lower horizons. In the fresh basalt the clay inclusions are quickly altered and, as a rule, only the resulting cavities can be observed. Within the lower few meters the exogenic inclusions account, on the average, for 0.4 percent of the rock mass, but in some places this figure may reach even 1.0 percent The volume of the zeolitic vesicles is on the average 1.0 percent of the whole rock mass, their diameter measuring 0,5 to 5,0 cm. The degree of zeolitization decreases irregularly in a southern direction, but occasionally accounts for 20 percent of the rock surface. A considerable part of the vesicles containing zeolite is filled by liquids that may represent the parent solution from which zeolite was precipitated. Zeolitization can frequently be observed around exogenic inclusions which suggests the clay minerals to have altered into zeolite.

The middle zeolitic basalt horizon (maximum 10 m thick) appears to represent an independent lava effusion because of its considerably different jointing. Its colour is mostly dark-grey, in some instances so dark that the rock might correspond to the "black" basalt referred to by J u g o v i c s (3, 4). This rock is conspicuous for its approximately vertical or somewhat southerly-inclined columnar jointing. In some places the columns suddenly become radially arranged over an area of a few tens of meters across. At the same time, we often can observe platy partings, too, which are normal to the former. The columns usually have a square section, their faces frequently covered by opal, and the other fissures and cracks ale likewise commonly filled by an opaline matter. Zeolitization is common in this horizon too, though the size of the zeolitic vesicles visible to the naked eye is somewhat smaller here (0.2 to 1.0 cm). The vesicles not completely filled by zeolite have, in this type too, an aqueous solution as additional filling.

The upper zeolitic basalt horizon is $4-6$ m thick, with small zeolitic vesicles, thick-bedded ($10-30$ cm). Near the surface this upper basalt horizon is usually altered, pseudo-agglomeratized in patches that can be traced from the top downwards. The patches are commonly rustbrown, but there are altogether light ochre ones, too, whose clay-mineralization product is montmorillonite. Similar basalt pseudo-agglomerates can be observed on the upper face of the southern pit of the quarry.

In the 1961 state of the quarry face a conical formation was observable in the central sector of the quarry. This consists of a mixture of sands with basalt detritus and quartz gravel cemented mostly by zeolite. The basalt above this cone is in the form of a pseudo-agglomerate $2-3$ m thick. Its circular cross-section resembles a parasitic crater, but it is conical instead of the funnel-shaped structure common for the craters of this type. It may be supposed from the above that we have to do with a pseudo-crater which resulted from the explosion of basalt lava that flowed on a swampy land surface, like that described by T h o r a r i n s s o n in Iceland (17).

The quarry is divided by the pseudo-crater into a southern and a northern pit. In the fifties a similar pseudo-crater was disclosed in the southern sector of the quarry.

The southern sector of the quarry is not subdivided into three portions like the northern one is. Here the basalt shows only columnar jointing assuming a blocky-columnar pattern towards the centre of the quarry, while at the southern extremity we can observe oblique columns of rectangular cross-section, 20 to 30 cm across, dipping in various directions.

Mineralogical composition

Plagioclase: Twin lamellae, having a labradoritic composition as suggested by the angle of extinction measured in the symmetric zone. In the upper horizon there is some andesine of $Ab_{60}An_{40}$ composition, too. Plagioclase is commonly devoid of inclusions, distinctly outlined, without any secondary alteration. The zeolitization of the plagioclase content of the ground-mass is unquestionable, but it cannot be detected under the microscope because of the extremely small sizes (Figs 3 and 4).

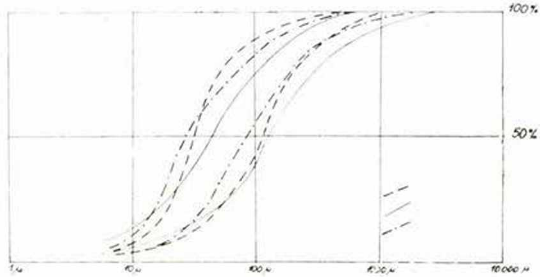

Fig. 3: Crystal-size distribution curves of the three basalt horizons indicating length and width data
– – Upper horizon
—— Middle horizon
–.– Lower horizon

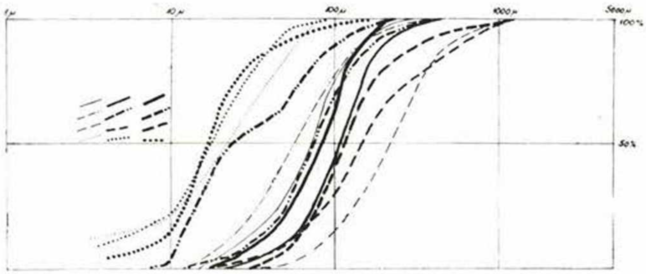

Fig. 4: Granulometric curves of the chief minerals of the zeolitic olivine basalts on the Láztető
– Plagioclase; – –.. Augite; – – Olivine; .... Magnetite;
thin line: lover – mean line: middle – thick line: upper horizon

Augite: This is the component most abundant besides plagioclase. Mostly automorphic. The twin-crystals of "hour-glass" structure typical of Ti-augite are also common. Devoid of inclusions, occasionally serpentinized. In the ground-mass one can observe an early segregation (300 to 100 μ on the average) and a later generation smaller by one order of magnitude. This latter forms agglomerations and augite-microlite rims around sandstone and clay inclusions. In some zeolitic vesicles two generations of augite and phillipsite can be detected: augite → phillipsite → augite → phillipsite → serpentine.

Olivine: Its proportion locally attains 20 percent. Its grains are mostly idiomorphic but amongst the smaller grains those having irregular outlines are also common. Every transition from the completely unaltered crystals up to the mostly serpentinized ones can be encountered. The type of serpentinization parallel with plane (021) and of stepwise arrangement can be observed in near-surface samples only. Serpentinization along strings parallel with planes (010) and (100) occurs frequently. Glass, picotite and magnetite represented by inclusions are scarce. The average grain size varies between 200 and 800 μ, but the length of grains of hexagonal cross-section reaches as much as 3 mm.

Predominant among the opaque components is *magnetite* of mostly triangular and square cross section, and sizes usually below 50 μ. The grains larger than 50 μ are commonly subhedral, and among the largest grains there are many anhedral ones, too. A common accessory mineral is *ilmenite* represented by typical pine-shaped skeletal crystals. In some places the translucent "pink-brown" flakes of titanomagnetite can also be observed (8). Most important of the accessory components are the zeolites the total amount of which in the quarry as a whole is 4 – 5 percent, but in some places as high as 20 percent. *Phillipsite* is the most common component occurring both in the ground-mass and in the vesicles. In the latter it often occurs in the form of pseudo-tetragonal twins with a size of mm order. Spectroscopic evidence shows that this mineral is rather rich in sodium, that it contains hardly any trace elements and is described by the formula: $(Na, K)Ca(Al_3Si_5O_{16}) . 6H_2O$. In the phillipsite of the ground-mass or filling joints and fissures we can often observe euhedral augite or magnetite. The presence of phillipsite in the ground-mass indicates that it belongs to the last products of crystallization, but is not necessarily a postvolcanic product. *Natrolite* is commonly found grown on phillipsite in the vesicles, but occasionally can be detected in the matrix as well (5 – 10 μ). The vesicles are sometimes observed to contain *analcite* formed subsequent to phillipsite. It is represented by square cross-sections, mostly isotropic or slightly birefringent. In some places it fills the vesicles completely. As regards the other accessory components, we can observe sporadical *biotite* lamellae, too (5 × 50 μ). The occurrence of *apatite needles* is more common. So far no regularity in the distribution of apatite could be revealed. There are places where its thin needles interlace the ground-mass almost completely, while at other places they are lacking. The calcite and aragonite as the last segregations occurring in the zeolitic vesicles are associated with clay inclusions. Glass is not everywhere represented. In the upper horizon, especially near the clay inclusions representing centres of cooling, it occurs more frequently.

4. Scoriaceous and vesicular basalt lava. As suggested by analyses under the microscope, it shows varied facies even within the individual occurrences. The vesicular or scoriaceous basalt usually has a glassy matrix. In the central part of the quarry even some varieties were encountered in which the ground-mass is crystalline with crystal sizes greater than the average. The glassy matrix is also rather diverse. In fact, its colour is either greenish due to serpentinization, or dark-brown due to limonitization.

The olivine in the vesicular oxibasalt is markedly hematitized and occasionally homogenized with the material of the surrounding rock glass.

The plagioclase laths often show an oriented arrangement around the vesicles the walls of which are lined in many cases by serpentine, sometimes by phillipsite and possibly by analcite. Sometimes the vesicles themselves exhibit an oriented arrangement. In such cases we can observe cavities up to 1–1.5 cm long and 1–2 mm wide, arranged perpendicularly to a particular joint face.

5. Exometabasalt (red oxibasalt). It occurs in some places, especially on the Vörösföldtető. Owing to the presence of hematite flakes, it is predominantly red, sometimes with a slightly purplish tint. Of its original mineralogical components plagioclase, magnetite and augite can be recognized; olivine has been completely altered, its presence being indicated only by a hematite and magnetite rim. The rock sometimes has a glassy matrix which is also strongly hematitized. Phillipsite is often detectable in vesicles and in the groundmass; natrolite being present in the filling of the vesicles only.

5. Basaltic pseudo-agglomerate. It can be found in the northern part, in the centre (near the pseudo-crater) as well as in the southern upper pit of the quarry. Pseudo-agglomerate is characterized by the alternation of basalt nodules with limonitic-clayey cement. At the southern extremity of the quarry this rock extends from the surface to a few meters depth within the upper basalt horizon. The microscopic image of the basalt nodules corresponds to that of the above-described zeolitic basalt, but on the edges of the nodules serpentinization and limonitization are coupled. In the composition of the clay-mineralized rock portions stained by limonite, only magnetite and augite can be detected of the original components, and the outlines of the plagioclase laths are visible. According to the DTA graph, the predominant clay mineral is Mg-montmorillonite. In some points of the altered portions of the pseudo-agglomeratic basalt found in the upper pit the plagioclase grains are strikingly large (300×50 μ on the average). These are twin-lamellar laths representing the second generation of plagioclase. Along with the augite crystals, magnetite shows a widely variable grain size and is represented by very large crystals in the upper lava horizon.

Order of segregation of the minerals

According to the analyses, the main components have segregated in the following order:

picotite, magnetite
olivine
augite (I)
plagioclase;
these were succeeded in varying order by
serpentinization
segregation of zeolite (I) — phillipsite-natrolite
phillipsite-analcite
analcite
plagioclase (II)
magnetite (II)
zeolite (II) — phillipsite-natrolite
serpentinization
carbonatization (rare)
decomposition into clay minerals.

In the case of zeolitization confined to vesicles, phillipsite is the oldest member formed long after serpentinization. It is followed by natrolite, analcite or augite, and finally serpentine or calcite is segregated. The relationship between phillipsite and natrolite in the ground-mass could not be cleared. *The Na-rich phillipsite of the ground-mass seems to have formed through alteration from plagioclase, while some of the potassium necessary for its formation may have derived from the sanidine rim of plagioclases and from the sanidine present in the interstices of the ground-mass laths (8).* The sanidine content of the ground-mass, however, is not a sufficient source of potassium; therefore, the rest of the K of phillipsite may have been introduced by waters which had ascended from the wet under-lying rocks (11).

In an ideal case the alteration can proceed as follows: plagioclase (albite + anorthite) + potassium + water = phillipsite

$$NaAlSi_3O_8 + CaAl_2Si_2O_8 + K^+ + H_2O = (Na, K)Ca(Al_3Si_5O_{16}).\ 6H_2O.$$

The appearance of augite, magnetite and plagioclase after serpentinization and zeolitization suggests that in the last, low-temperature phase of crystallization these were still being formed. At the same time, the shape of augite does not permit to conclude as to the temperature of formation, as augite is represented by automorphic, slightly elongated cross-sections mostly parallel to the c axis in any size and any environment. In the zeolitic vesicles it can be observed that first augite is formed on the wall of the cavity, then it is followed by zeolite, and after a new augite zone a second zeolite generation predominantly consisting of phillipsite is formed. In such cases augite is altogether automorphic. The augite rim bordering the exogenic clay inclusions on the wall of zeolitic vesicles as well as the augitic components of the ground mass — which show a considerably smaller grain size — suggest that they have developed from exogenic clay inclusions under the effect of heat.

The remarkable changes in the mineralogical composition of the rock even within small distances outside the inclusions indicate that the formation of minerals was influenced by local factors which have so far not been taken into consideration to such an extent as would have been proper. In the formation of the ground-mass interlaced by apatite needles and of the ilmenite skeleton crystals the effect of the melted rock inclusions may have been involved. (In some places analcite, in other places phillipsite is the predominant vesicle-filling mineral).

After the crystallization of the bulk of the basalt the following late and post-solidification mineralization processes can be shown to have taken place:

a) Serpentinization which had begun nearly simultaneously with the crystallization of olivine.

b) Zeolitization of the ground mass.

c) Zeolitization confined to the vesicles.

d) Formation of exometabasalt and pseudo-agglomerate under the influence of exogenic oxidation and clay-mineralization (13).

e) Iddingsitization which, as contrary to I. Vörös's (16) investigations on the Kabhegy, was induced here by exogenic effects alone.

Chemical composition

A. Guzy-Somogyi (Hungarian Geological Institute) has analysed 6 samples from the rocks of the Láztető:

1. Basalt from the lower horizon, northern pit
2. Basalt from the middle horizon, northern pit
3. Basalt from the upper horizon, northern pit
4. Basalt from the N part of the Láztető, outcrop
5. Zeolitic olivine basalt from the southern pit
6. Pseudo-agglomeratized basalt from the upper horizon, southern upper pit.

The mineralogic composition of 3 basalt horizons of the northern pit has been evaluated in terms of chemical composition. The mineralogy and chemical analysis of these samples is shown in Table 1.

Table I.

Mineralogic composition of one sample from each of the three basalt horizons as evaluated in terms of chemical composition, compared to the chemical analyses of the original sample

Lower horizon	Volume percent	Weight percent	SiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	Na_2O+K_2O	H_2O
Plagioclase	56	50	26.5	15.0	–	–	–	5.0	3.5	–
Magnetite	3	5	–	–	3.4	1.6	–	–	–	–
Olivine	14	17	6.8	–	–	5.1	5.1	–	–	–
Augite	21	22	10.6	1.1	0.5	1.8	3.5	4.4	0.1	–
Zeolite	3	2	0.9	0.5	–	–	–	0.1	0.1	0.4
Other constituents (serpentine)	3	3	1.3	–	–	–	1.3	–	–	0.4
Total	100	100	46.1	16.6	3.9	8.5	9.9	9.6	3.7	0.8
Chemical analysis .			47.0	15.0	3.0	7.1	8.0	8.1	5.6	2.3
Analysis converted to 100 percent			48.9	15.6	3.1	7.3	8.4	8.5	5.8	2.4
Divergences from the analysis			– 2.8	+ 1.0	+ 0.8	+ 1.2	+ 1.5	– 1.1	– 2.1	– 1.6
Middle horizon										
Plagioclase	51	46	24.4	13.8	–	–	–	4.6	3.2	–
Magnetite	2	3	–	–	2.1	0.9	–	–	–	–
Olivine	16	19	7.6	–	–	5.7	5.7	–	–	–
Augite	24	26	12.5	1.3	0.6	2.1	4.2	5.2	0.1	–
Zeolite	5	4	1.8	0.9	–	–	–	0.2	0.3	0.8
Other constituents .	2	2	0.9	–	–	–	0.8	–	–	0.3
Total	100	100	47.2	16.0	2.7	8.7	10.8	10.0	3.6	1.1

Table I.

Lower horizon	Volume percent	Weight percent	SiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	Na_2O+K_2O	H_2O
Chemical analysis			46.8	14.9	2.9	7.1	7.5	8.7	5.7	2.5
Analysis converted to 100 percent			48.7	15.5	3.0	7.4	7.8	9.1	5.9	2.6
Divergences from the analysis			−1.5	+0.5	−0.3	+1.3	+2.9	+0.9	−2.3	−1.5
Upper horizon										
Plagioclase	45	42	22.1	12.8	–	–	–	4.2	2.9	–
Magnetite	2	3	–	–	2.1	0.9	–	–	–	–
Olivine	7	9	3.6	–	–	2.7	2.7	–	–	–
Augite	27	32	15.3	1.6	0.8	2.6	5.1	6.4	0.2	–
Zeolite	15	11	5.0	2.6	–	–	–	0.6	0.9	1.9
Other constituents .	4	3	1.3	–	–	–	1.3	–	–	0.4
Total	100	100	47.3	17.0	2.9	6.2	9.1	11.2	4.0	2.3
Chemical analysis .			46.3	14.8	2.2	7.2	7.6	8.4	5.5	4.4
Analysis conwerted to 100 percent			47.9	15.4	2.3	7.5	7.9	8.7	5.7	4.6
Divergences from the analyses			−0.6	+1.6	+0.6	−1.3	+1.2	+2.5	−1.7	−2.3
Idealized composition of the minerals evaluated										
Plagioclase			53.0	30.0	–	–	–	10.0	7.0	–
Magnetite			–	–	69.0	31.0	–	–	–	–
Olivine			40.0	–	–	30.0	30.0	–	–	–
Augite			48.0	5.0	2.5	8.0	16.0	20.0	0.5	–
Zeolite			46.0	23.0	–	–	–	6.0	8.0	17.0
Other constituents (serpentine)			44.0	–	–	–	43.0	–	–	13.0

Table 2

	1.	2.	3.	4.	5.	6.
SiO_2	46.96	46.77	46.27	46.74	45.30	47.48
TiO_2	1.76	1.90	1.69	1.79	1.78	1.79
Al_2O_3	15.03	14.92	14.81	14.83	14.45	15.17
Fe_2O_3	3.03	2.94	2.21	3.96	3.21	7.14
FeO	7.01	7.12	7.16	6.22	6.74	3.06
MnO	0.57	0.44	0.44	0.47	0.38	0.44
MgO	7.95	7.53	7.63	7.44	7.41	5.87
CaO	8.14	8.67	8.39	8.36	8.58	8.93
Na_2O	3.48	3.31	3.45	3.92	2.75	3.39
K_2O	2.09	2.37	1.98	1.05	2.27	0.95
^+H_2O	2.31	2.47	4.39	2.96	5.37	2.96
^-H_2O	0.73	0.71	0.81	0.78	1.07	2.31
CO_2	tr	tr	–	–	tr	–
P_2O_5	0.72	0.74	0.68	0.78	0.72	0.76
SO_3	–	–	–	0.49	–	–
Total	99.78%	99.89%	99.91%	99.79%	100.03%	100.25%

It is evident from the analyses that the 6 samples show no substantial differences in chemical composition. The differences will be even more insignificant, if ^-H_2O and the amount of ^+H_2O higher than 1 percent are disregarded. The comparison of the basaltic rocks of Transdanubia indicates that the chemical composition of zeolitic and zeolite-free basalts is essentially the same (9) and alone the amount of ^+H_2O is higher in the zeolitic basalt. The amount of ^+H_2O in zeolite-free basalts averages 1 percent. Thus, if disregarding the various "zeolitic" water contents exceeding 1 percent and ^-H_2O which are not characteristic anyway, a table providing a sounder basis for comparison will be obtained:

*Table 3**

	1.	2.	3.	4.	5.	6.
	97.74= =100%	97.71= =100%	95.71= =100%	97.05= =100%	94.59= =100%	95.98= =100%
SiO_2	48.00	47.80	48.32	48.22	47.90	49.52
TiO_2	1.80	1.94	1.77	1.84	1.90	1.86
Al_2O_3	15.42	15.35	15.50	15.31	15.27	15.80
Fe_2O_3	3.10	3.00	2.30	4.06	3.40	7.35
FeO	7.18	7.29	7.48	6.40	7.11	3.20
MnO	0.58	0.45	0.46	0.48	0.40	0.46
MgO	8.12	7.73	7.97	7.65	7.83	6.15
CaO	8.34	8.88	8.77	8.60	9.07	9.30
Na_2O	3.56	3.39	3.58	4.03	2.90	3.53
K_2O	2.14	2.42	2.09	1.08	2.40	1.00
^+H_2O	1.02	1.02	1.05	1.03	1.06	1.04
^-H_2O	–	–	–	–	–	–
P_2O	0.74	0.73	0.71	0.80	0.76	0.79
SO_3	–	–	–	0.50	–	–
	100.00	100.00	100.00	100.00	100.00	100.00

* The total of the components analyzed minus the water content was taken as 100 percent.

The K content of surface or near-surface samples is lower than the average. This suggests that K enters more mobile components easier than Na does, so that it escapes from the rock near the surface. The observed decrease of the Mg content in one of the samples cannot be regarded as a regular phenomenon. The total iron content is essentially the same in all the samples. The only difference lies in the fact that in the near-surface samples the degree of oxidation is higher. The value $O_{Fe} = \frac{(2Fe_2O_3)}{FeO}$ for sample 6 is higher than 4.5, in contrast to the samples from the deeper levels where $O_{Fe} = 0.6$ to 0.9. The other zeolitic basalts of Transdanubia show similar O_{Fe} values.

Texture

The texture of the rock represents a transition between microholocrystalline and pilotaxitic, though there are portions where one of these texture types is represented in pure from. Glass appears chiefly around exogenic inclusions. Figs 3 and 4 show the granulometric distribution of basalt samples taken from the three successive horizons of the quarry. It is shown by the figures that the average grain size is the largest in the middle horizon and that the plagioclase and augite grains also have the largest size in this same horizon. The grains in the upper horizon are elongated, while in the lower horizon it is only the smaller grains that show long axes longer than the diameter. In the lower horizon the mean grain size of olivine and magnetite is relatively the largest. Fluidal texture cannot be observed, and since no substantial changes occur in the texture, apart from the surroundings of inclusions, it may be presumed that the basalt was consolidated in a lava pool. On the other hand, the radially columnar jointing and the concentric parting perpendicular to it in the middle horizon of the quarry testify to the presence of a lava flow.

Further exploitation of the quarry is expected to contribute to a better understanding of the volcanic activity, and to the solution of still open questions.

REFERENCES

1. Bidló G.: Az uzsapusztai Lázhegy petrokémiai viszonyai (Petrochemistry of Lázhegy Hill at Uzsapuszta). Földtani Közlöny, 86. 1956.
2. Jugovics, L.: A Zalaszántó-Zsid-i medence bazalthegyeinek (Tátika-csoport) felépítése [Geological structure of the basalt hills in the Zalaszántó-Zsid basin (Tátika hill group)]. Földtani Intézet Évi jelentése 1945–1947.
3. Jugovics, L.: Adatok a Tátika – Prága – Sarvaly hegyek vulkanológiai felépítéséhez (Contribution to the knowledge of the volcanologic constitution of the hills Tátika – Prága – Sarvaly). Földtani Közlöny, 78. 1948.
4. Jugovics, L.: A D-i Bakony és a Balatonfelvidék bazalt-területei (The basalt areas of the Southern Bakony and the Balaton Highland). Földt. Int. Évi jel. 1953. I.
5. Jugovics, L.: Újabb vulkanológiai és kőzettani megfigyelések a Tátika csoport bazalthegyein (Recent volcanologic and petrographic observations on the basalt hills of the Tátika group). Földt. Int. Évi jel. 1955–56 (1959).
6. Kulcsár, L. – Guzy-Somogyi, A.: A Celldömölki Sághegy vulkánja (The volcano of the Sághegy at Celldömölk). Acta Geographica Debrecina VII/I. Debrecen, 1962.

7. Lóczy, L. sen.: A Balaton környékének geológiai képződményei és ezeknek vidékek szerinti telepedése (Geological formations of the Balaton Region and their mode of occurrence in the individual areas). *A Balaton tudományos tanulmányozásának eredményei. I. Budapest*, 1913.
8. Mauritz, B. – Harwood, H. F.: A Tátika csoport bazaltos kőzetei (Basaltic rocks of the Tátika group). Mat. és Term. tud. Ért. 55. 1937.
9. Mauritz, B.: A dunántúli bazaltok kőzetkémiai viszonyai (Petrochemistry of the Transdanubian basalts). Földtani Közlöny, 78, 1948.
10. Nashar, B. – Davies, M.: Secondary Minerals of the Tertiary basalts, Barrington, New South Wales. Mineralogical Magazine. V. 32. 1960.
11. Szádeczky-Kardoss, E. – Erdélyi, J.: A balatonvidéki bazaltok zeolitjainak képződéséről (On the formation of zeolite in the basalts of the Balaton Region). Földtani Közlöny, 87. 1957.
12. Szádeczky-Kardoss, E.: A vulkáni hegységek kutatásának néhány alapkérdéséről (On some basic problems of investigation into volcanic mountains). Földtani Közlöny, 88. 1958.
13. Szádeczky-Kardoss, E.: A magmás kőzetek új rendszerezésének elvi alapjai (Basic principles of the new classification of igneous rocks). MTA Műszaki Oszt. Közl. XXIII. v. 3–4. 1959.
14. Szádeczky-Kardoss, E.: A kárpáti tömeg magmás mechanizmusáról (On the igneous mechanism of the Carpathian massif). MTA Geokémiai Konferenciájának kiadványa I. Budapest, 1959.
15. Vitális, I.: Balatonvidéki bazaltok (The basalts of the Balaton Region). A Balaton tudományos tanulmányozásának eredményei I. Budapest, 1913.
16. Vörös, I.: Iddingsitesedés a kabhegyi bazaltban (Iddingsitization in the basalts of the Kabhegy). Földtani Közlöny 92. 1962.
17. Williams, H.: Problems and progress in volcanology. Quarterly Journ. of the Geol. Soc. of London. v. CIX. 3. No. 435. 1954.